U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 78.

Experiment Station Work—V.

HUMUS IN SOILS.
SWAMP, MARSH, OR MUCK SOILS.
RAPE.
VELVET BEAN.
SUNFLOWERS.
WINTER PROTECTION OF PEACH TREES.
SUBWATERING IN GREENHOUSES.
BACTERIAL DISEASES OF PLANTS.
GRAPE JUICE AND SWEET CIDER.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1898.

CONTENTS OF THE SERIES OF FARMERS' BULLETINS ON EXPERIMENT STATION WORK.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., April 15, 1898.

SIR: The fifth number of Experiment Station Work, prepared under my direction, is transmitted herewith with the recommendation that it be published as a Farmers' Bulletin.

Respectfully,

A. C. TRUE,
Director.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

EXPERIMENT STATION WORK—V.[1]

THE IMPORTANCE OF MAINTAINING A SUPPLY OF HUMUS IN THE SOIL.

One of the most important elements of soil fertility is the partially decomposed animal and vegetable substances (organic matter) which is known as humus. It has been shown that a decline in fertility is not entirely the result of the removal from the soil of the essential fertilizing constituents—nitrogen, phosphoric acid, potash, or lime—but is due in many cases to a loss of humus. The loss of humus is due to a variety of causes, among which are (1) the continuous growth on a soil of a crop which does not return any residue to the soil; (2) systems of cultivation which leave the bare soil exposed to the action of the oxygen of the air, such as summer fallowing and fall plowing, and (3) forest fires.

Investigations by the Minnesota Station have shown that there are serious losses of humus from all these causes, but that probably the greatest decline in fertility in the soils of that region was due to continuous grain cropping. It was found that soils so cropped were in many cases abundantly supplied with nitrogen, phosphoric acid, and potash, and were not benefited by applications of fertilizers containing these substances; but there had been a decided decrease in the amount of humus which the soils contained, and this undoubtedly accounted for the observed decline in their productive power. That this was true was shown by the fact that with methods of farming in which humus-forming materials were returned to the soil its productive power either did not decline or declined much slower than when crops like wheat, cotton, or potatoes, which leave little residue on the soil, were grown continuously.

[1]This is the fifth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended on to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

The same station has recently carried on experiments to compare the influence of continuous grain cropping and rotation of crops on the humus content and fertility of soils. On one plat each wheat, corn, oats, and barley were grown continuously for four years. On another plat the following rotation was practiced: Wheat, clover, wheat, and oats. On still another plat oats followed by clover, barley, and corn (with manure) were grown.

The gain or loss of humus during four years in the soil of the different plats is shown in the following table:

Gain or loss of humus in soils under different systems of cropping.

System of cropping.	Humus at the beginning of the experiment.	Humus at the end of 4 years.	Gain (+) or loss (—).
	Per cent.	*Per cent.*	*Per cent.*
Plat 1, wheat continuously	3.30	3.00	—0.30
Plat 2, rotation (wheat, clover, wheat, and oats)	3.30	3.80	+ .50
Plat 3, rotation (oats, clover, barley, and corn)	3.30	3.50	+ .20
Plat 4, corn continuously	3.30	3.10	— .20
Plat 5, oats continuously	3.30	3.08	— .22
Plat 6, barley continuously	3.30	3.10	— .20

From the data thus obtained it is calculated that with continuous wheat raising there was an annual loss of 1,800 pounds of humus per acre. The annual loss from continuous cropping with corn, oats, and barley was about 1,500 pounds of humus per acre. On the other hand, on the rotation plats there was an annual gain of about 1,500 pounds of humus per acre in one case and over 2 tons in the other.

Since humus is one of the principal sources of nitrogen in the soil, these variations of the humus content affected to a marked extent the supply of nitrogen. In the case of continuous wheat growing there was an annual loss of 146 pounds of nitrogen per acre over and above that utilized by the wheat. In other words, for every pound of nitrogen removed in the wheat crop there was a loss of over 5 pounds of nitrogen from the soil. In the case of oats, the loss was 150 pounds; with barley, 170 pounds; with corn, 29 pounds.

On the first rotation plat there was an annual gain of 61¼ pounds of nitrogen per acre, notwithstanding the fact that larger crops were grown on this soil than on those cultivated continuously in the same crop. A gain of nitrogen was also observed in case of the second rotation plat, although it was smaller than in case of the first, probably on account of the poor stand of clover secured, since it is believed that the increase of nitrogen in the rotation plats was due largely to that gathered by the clover from the free nitrogen of the air.

Humus is not only the principal source of nitrogen in the soil, but it influences to a marked extent the available potash and phosphoric acid. Humus-forming materials, like green manures and barnyard manure, have the power, when they decompose in the soil, of combining with the potash and phosphoric acid of the soil and thus converting them into forms which are readily utilized by plants.

The influence of the loss of humus upon the physical properties of the soil is fully as important as its effect upon the chemical properties. The retentive power of soils for water and for fertilizers declines rapidly with a decrease in its humus content. It is well established that applications of lime and commercial fertilizers give the greatest return on soils well stocked with humus. Soils with a liberal amount of humus are capable of more effectively withstanding drought than similar soils with less humus. Determinations of moisture in the soils, upon which the above experiments were made, almost invariably showed a higher percentage of water in the rotation plats than in those on which the grains were grown continuously.

In arid regions and in sandy soils the loss of humus is most severely felt. Under these conditions the humus of the soil should be "increased by the use of well-prepared farm manures, green manures, and by a systematic rotation of crops in which grasses, or preferably clover, form an important part."

There are certain soils, however, that do not need humus. "Ordinary prairie soils, for the first ten years after breaking, are usually well supplied with humus. Swampy, peaty, and muck soils contain large amounts of humus. If the soil is sour to the taste, the acid may be neutralized by a dressing of lime or wood ashes. Soils from poorly drained places frequently contain sour humus. Very frequently muck soils are deposited over marl beds. Marl, which is a mixture of limestone and clay, may be used as a top-dressing for the muck soils."

From the above it is seen that a soil well stocked with humus will withstand drought better, furnish more available plant food, and hence larger crops, and give better returns for fertilizers applied than one deficient in this substance.

SWAMP, MARSH, OR MUCK SOILS.

The great value of these soils when properly reclaimed has led European farmers and investigators to devote much attention to their utilization, and increased attention is being directed to the same subject in this country. The salt marshes, especially along the New England coast, have been extensively used for many years for the production of forage, and in many cases expensive and elaborate systems of reclamation have been carried out on them. Reclaimed swamp or muck soils are being extensively utilized in Michigan, Ohio, and other regions for the production of celery and onions, for which they seem to be peculiarly adapted. Several of the experiment stations, notably those of Wisconsin, Indiana, and Michigan, have undertaken to study the best means of reclaiming such soils.

While the conditions vary considerably in different cases and each soil may present some peculiar conditions of its own, the general principles and practices are the same for all this class of soils. Thorough drainage is the first essential. This is not only necessary for the purpose of removing the excess of water, but to allow the free circulation of

air in the soil, in order that the poisonous compounds which are usually present may be oxidized and thus rendered harmless, and that the processes of decomposition and nitrification so necessary in this class of soil may be set up.

The drainage is best accomplished at first by means of open ditches at frequent intervals. Muck soils settle greatly when drained, and if tiles are laid in the soft muck they will rise toward the surface, and thus become ineffective. Draining is most effective when carried out gradually, and the soil should not be allowed to dry out too quickly, since its mechanical condition may be thus injuriously affected, its absorptive power for water in many cases almost completely destroyed, and the decomposition of the organic matter greatly retarded. After the soil has become firm tiles may be laid, especially if collars are used.

The Indiana Station has shown that in case of the black soils of that State, which are probably representative of a class, tile drainage is effective only when the sand and gravel which underlie such soils are tapped. By sinking in this underlying layer of sand or gravel a series of wells which are connected with tile at the depth at which it is desired to maintain the water level, the soils may probably be thoroughly drained without difficulty.

It is frequently found that muck soils, even after the most careful draining, are still unproductive. The fertilizing matter which they contain is in unavailable condition for plants. A common practice in Ireland and in European countries is to pare the surface and after drying to burn the organic matter. This practice of burning has been condemned as exhausting to the soil, but without good reason. The burning should not extend more than 12 to 16 inches and it destroys very little available plant food. It is recommended as one of the quickest methods of putting muck soils into condition for the growth of crops. The ashes and charred matter spread over the surface of the soil greatly improve its mechanical condition, while the burning increases the solubility of the organic compounds in the soil. It frequently happens that muck soils have to be liberally manured before they will produce remunerative crops. From the nature of their formation such soils are likely to be deficient in phosphoric acid and potash, and the experiments of the Wisconsin Station have shown that, notwithstanding the fact that they are often composed almost entirely of organic matter containing large amounts of nitrogen, the available nitrogen in them is frequently very deficient.

The first object sought in fertilizing should be to correct the acidity of the soil and to set up the processes of decomposition of the organic matter and nitrification, so as to convert the inert into available plant food. Liberal applications of decomposing manures, such as barnyard manure, in connection with dressings of lime have usually been found effective for this purpose. As the Wisconsin Station has shown, lime and the bulky manures exert a beneficial effect on the texture of the soils, rendering them more porous, and thus improving drainage and

increasing aeration and nitrification. Liberal applications of wood ashes also improve the texture of the soil, correct acidity, and favor nitrification, and at the same time furnish potash and phosphoric acid, which are likely to be deficient. The by-product from steel manufacture, known as Thomas slag, is used with good results on such soils in Europe. It is rich in lime and thus effective in correcting acidity and promoting nitrification, and it also supplies phosphoric acid. It is generally applied in the fall in connection with some potash salt such as kainit or muriate of potash. It is doubtful, however, whether this slag can be obtained at present in the United States at a price sufficiently low to justify its use for this purpose. A dressing of lime (30 to 40 bushels per acre), followed by an application of a mixture of kainit or muriate of potash with some cheap phosphate, such as fine-ground Florida phosphate, may be substituted for the slag mixture. The untreated mineral phosphates have been used with advantage on muck soils, the decomposing organic matter assisting in rendering the phosphoric acid available.

Covering bogs with a layer of sand or gravel 4 to 6 inches thick has been successfully practiced in Ireland and European countries, but it is doubtful whether this method is generally applicable in the United States.

Oats, potatoes, and buckwheat have been found to thrive better than wheat or clover on recently reclaimed bogs. The grasses generally have been successfully grown on such soils, and, as already stated, they seem to be well adapted to celery and onions and are extensively used for the growth of these crops. In Europe sugar beets are grown with good results on such soils.

RAPE.

The rape plant, like the turnip and ruta-baga, belongs to the Cruciferæ or mustard family. The roots, however, are fibrous and not thickened like those of the turnip. It is extensively grown in Europe for its seed, from which an oil is obtained, and for its leaves, which are used for forage. Rape has long been recognized abroad as an important forage plant, and it bids fair to become a valuable fodder crop in this country, especially in the northern tier of States. Experiments have been carried on to determine its adaptability to various regions and soils and its value for feeding purposes. In a recent bulletin the Wisconsin Experiment Station summarizes its experience with the rape crop for soiling and fattening sheep and swine, and gives directions for its culture for this purpose.

Like most rank-growing crops, rape prefers a rich soil. During five years of experimenting at the Wisconsin Station the crop was grown on different kinds of soil, and it was found that a warm, friable soil, rich in humus, or decaying vegetable matter gave the best results. Old pasture lands when brought to a fine tilth are considered exceptionally good for rape. The best results in the series of experiments were obtained on newly broken land.

To prepare the land for rape it is advised to plow in the fall and to bring the land to a fine tilth by means of a pulverizer early in the spring.

Drilling the seed in rows 30 inches apart proved most satisfactory. When drilled in rows the crop can be cultivated, and the moisture conserved in this way enables it to withstand dry weather. Besides, when drilled the plants grow taller and make better forage than when broadcasted. This confirms results obtained at the Michigan Station. Sowing the seed on ridges did not seem to have any advantages. Two pounds of seed per acre are recommended for sowing in drills and 3 pounds for broadcasting.

If the crop is grown for soiling purposes, the seed should be sown as soon as the land is prepared. "If sown early in May, it will be ready to cut and feed for the first time early in July, and if the season is but an average one it is possible to get two more satisfactory cuttings from the same piece before the snow comes in November." By cutting the plants 4 inches above the ground, which best enables them to throw out new shoots, and cultivating between cuttings, it is estimated that about 30 tons of green forage may be obtained from an acre. In some sections rape is sown the latter part of June or the beginning of July. Sowing rape in oats and harrowing it in just after the oats are out of the ground, or sowing it in the spring in fall-sown rye, gave better results than sowing it between the rows of corn at the time of the last cultivation; but, on the whole, these methods were not very satisfactory and indicated that it is best to grow the crop by itself.

There are many varieties of rape, some annuals and a few biennials. The annual varieties are valued for their seed and the biennial for fodder. The Dwarf Essex rape was the only variety grown at the Wisconsin Station. It is a biennial variety which has been tried in a number of States and in Canada, and is one of the most reliable varieties of fodder rape known. In comparative trials of 11 varieties of rape at the Minnesota Station, Dwarf Essex produced the largest yield.

The Wisconsin Station has also experimented with rape as a feed for sheep, lambs, and pigs.

The average gain of lambs fattened on rape was 2½ pounds per head weekly. A pound of grain per head daily is the average amount fed with the rape. It is regarded as a conservative estimate that 40 lambs fed on an acre of rape and given some pasturage and an average of 1 pound of grain per head daily in addition will produce at least 400 pounds of mutton in one month.

In experiments at the Michigan Station 1 acre of rape afforded pasturage for 9 lambs for 7 weeks and produced a total gain of 202½ pounds, or 22½ pounds per lamb.

In feeding the rape certain precautions must be observed. Until they are accustomed to it lambs should not be turned on to rape without

first grazing them on pasture for about two hours, otherwise they are liable to bloat. Better gains will also be obtained when lambs are pastured in addition to being fed rape. As a further precaution against danger from scouring or bloating, it is considered advisable to confine the lambs to a small area with hurdles until they are accustomed to the rape. Before feeding rape it is considered necessary to dock and trim the tails of the lambs. If they have been on poor pasture, it is advisable to feed them some grain in addition for a week or so before turning them on to rape, and then to accustom them to it gradually. Thus, they may be pastured during the forenoon and turned on the rape for a short time each afternoon. If swelling of the stomach is noticed, they should be taken from the rape at once. In a short time they become accustomed to the rape.

In addition to pasturage and rape, care should be taken to feed grain. One-half pound per head daily is a liberal allowance at first if it is eaten with relish, otherwise a smaller amount. Oats are regarded as the safest grain to use at the beginning, but as corn is more fattening it may be gradually substituted for oats, with such foods as peas or linseed meal when practicable.

The bloating or hoven, which results from eating too much succulent food, is caused by an accumulation of gas, due to fermenting material in the stomach. A teaspoonful of spirits of ammonia in a half pint of water will usually relieve the trouble if given immediately. If the bloating has progressed too far for this treatment, the stomach should be punctured at the point of greatest swelling with a trocar and canula. Scouring is an indication of too much rape, and may be counteracted by keeping the lambs longer on pasture.

When it is desired to feed lambs for two or three months during the winter and to put them on the market in January, a month's run on the rape field previous to the final fattening has been found beneficial. Not only are the gains on rape satisfactory, but the subsequent gains are better than when lambs are pastured alone during the preliminary feeding period. At the Michigan Station it was found impracticable to pasture rape later than November 15. Animals pastured on rape after it had been frosted were especially subject to digestive disorders.

The Wisconsin Station has fed rape to pigs with uniformly satisfactory results. It was sometimes found necessary to limit the amount of other foods until the pigs became accustomed to the rape. As an average of two trials recently reported, it was found that 1 acre of rape was equivalent to 2,767 pounds of mixed grain (2 parts corn and 1 part shorts). It is believed that rape will prove as valuable for pigs as for sheep. It may be fed to pigs with less risk, since they do not bloat on it or scour if fed properly. It will doubtless prove valuable as pasturage for brood sows and young pigs, and seems especially valuable for swine feeding during the hot summer months, because of its succulence and the relish with which it is eaten.

The construction and use of the hurdles used in the above experiments for sheep and hogs is shown in the accompanying illustrations (figs. 1 and 2).

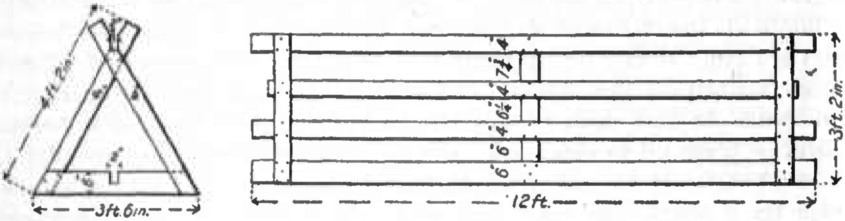

FIG. 1.—Hurdles.

Recent experiments at the Rhode Island Station indicate that rape is very useful as a green feed for geese. It should be sown quite early in the spring for the young goslings, and they may be hurdled upon it as soon as the plants are 6 inches high. They will eat the tender portion of the leaves, rejecting the stalks and crowns of the plants unless confined too long in one place. As soon as the goslings are removed to

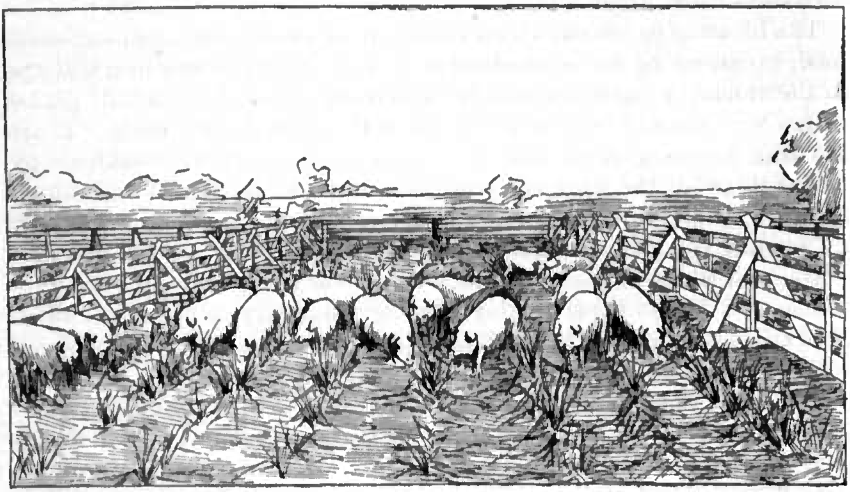

FIG. 2.—Pigs hurdled on rape.

another place the plants begin to make new growth and thus the goslings may be grazed repeatedly on the same piece of rape if the hurdling is properly done. The gains made on rape were satisfactory and it is regarded as equal to tender grass and young growing grain as forage for young geese.

VELVET BEAN.

This leguminous crop has been grown in some parts of the South as an ornamental vine for a number of years, and is now beginning to be recognized as a valuable forage crop and soil renovator. The plant has attracted considerable attention among farmers in the Gulf States, but its use for forage, green manure, and soil renewing is as yet the

exception rather than the rule. It seems, however, that in regions where it can be successfully grown it may become a rival of the well-known cowpea.

The plant is described in a bulletin of the Florida Station as follows: "The pods are very thick and leathery; do not crack open when ripe, and are difficult to open by hand. The pods contain from three to five large, plump, fine-looking beans, irregularly colored with purplish and brownish patches. The foliage is much like that of other beans. The vines grow from 10 to 20 feet in length."

The Florida Experiment Station has reported a culture experiment with the velvet bean, and the results which were obtained are quite promising. The plat upon which the experiment was conducted comprised about one-fourth of an acre of very poor soil. The soil was prepared as for corn, and the beans were planted in rows 3 feet apart and about 1 foot apart in the row. The plat was kept free from weeds until the rapidly growing vines shaded the ground and covered it with dense vegetation. A square rod produced 93 pounds of green forage, which was at the rate of 16,680 pounds per acre. It is estimated that the yield of hay would have been from 2 to 3 tons per acre.

Its use as a green forage for all kinds of stock and as a crop to be grown in orchards for its fertilizing value is recommended by practical men who have given it a trial. The luxuriant growth of the crop well adapts it to shading, mulching, and fertilizing the soil. Furthermore, like other legumes, the velvet bean gathers nitrogen from the air and thus acts as a valuable fertilizing agent for whatever purpose it may be grown, although the greatest benefit to the soil results from growing it for green manuring. Besides storing nitrogen, the crop serves as a mulch, and when turned under adds humus to the soil, improving it physically and mechanically. This is of great importance, especially when the renovation of the soil is dependent on the use of commercial fertilizers.

The seed may be planted in drills or rows 4 feet apart each way, putting from three to five beans in the hill. Some growers drop beans every fourth or fifth furrow while plowing the land, and cover them with the following furrow. It requires about 16 quarts of seed per acre when planted in every fourth furrow. The planting should be done early in the spring. The yield of beans is estimated at about 20 bushels per acre.

An analysis of an air-dried sample of the beans made at the Florida Station gave the following results:

Composition of velvet beans (seeds) in air-dry condition.

	Per cent.
Moisture at 100° C	11.93
Protein	18.81
Fat (ether extract)	6.29
Fiber	7.45
Nitrogen-free extract	53.50
Ash	2.02
Albuminoid nitrogen	2.87

This analysis, calculated to a water-free basis and compared with an analysis of the cowpea calculated to the same basis, is given below:

Relative composition of seeds of velvet beans and cowpeas in water-free condition.

	Velvet beans.	Cowpeas.
	Per cent.	*Per cent.*
Protein	21.36	14.00
Fat	7.14	2.60
Fiber	8.46	29.00
Nitrogen-free extract	60.75	43.60
Ash	2.29	10.50

No feeding experiments with the velvet bean have as yet been reported, and its percentage of digestibility has not been determined. It is stated that if the digestibility equals that of the cowpea it would compare quite favorably with the latter for feeding purposes. "It is to be classed among those feeding stuffs which are especially rich in nitrogen (protein substances). A feeding stuff so rich in nitrogen should not be fed alone but in conjunction with some coarse fodder containing a much larger proportion of carbohydrates (starches, etc.), such, for example, as corn fodder."

It is reported that the beans ground in the pod have been fed to milch cows with good results, but that the animals do not take to them readily at first and horses refuse to eat the ripe beans in the pod. It is also reported that persons have been made sick by eating the cooked, green shelled beans and chickens have been killed by eating the beans, both in the cooked and the raw state. The beans, therefore, should be tested as a food and feeding stuff with the utmost caution.

The velvet bean seems to thrive best in the extreme South and can not be grown with success as far North as the cowpea. A culture test was made at the North Carolina Station. The seed started slowly, but when the plants once were well established they made vigorous growth. Owing to the long season of growth of the plant, it did not bloom until September 20, and was injured by frost about a month later. Only a few pods were full grown at this time and no seed ripened.

SUNFLOWERS.

The sunflower (*Helianthus annuus*), like the closely related Jerusalem artichoke,[1] is a native of North America. Champlain found the natives of Lower Canada growing it for the oil which its seeds furnish. Wild varieties of it are widely distributed in this country. It was introduced into Europe about the middle of the sixteenth century, and is now widely grown there, principally for its seeds and oil. The cultivation of it is extensively engaged in at the present time in southern Russia, India, and Egypt, as well as in Austria, Italy, and Turkey. The sunflower has been cultivated to some extent in almost all parts

[1] U. S. Dept. Agr., Farmers' Bul. 73 (Experiment Station Work—III).

of the United States and in Canada, either as an ornamental plant or for its seed. Several varieties are cultivated, but the Mammoth Russian is generally considered best, especially for the production of oil. Single-headed varieties are recommended for seed production. If a variety is grown which will produce several heads, it is claimed that better seed will be obtained if only one head is allowed to mature on each plant.

Sunflowers grow best on a light, well-drained, well-tilled, and fertile soil. On such soil a yield of from 30 to 50 bushels, and sometimes more, of seed per acre may be expected. The California Station has shown that the sunflower grows well on soil containing large amounts of alkali. The preparation of the land for this plant and its subsequent cultivation is similar to that required by corn.

The seed may be planted 2 to 4 inches deep, in hills 3 feet apart, in rows 3 or 3½ feet apart, or drilled in rows 3 or 3½ feet apart, the young plants being thinned when 8 to 10 inches high to 12 to 16 inches apart in the row. When planted in drills, from 10 to 15 pounds of seed are required per acre. Since the seeds are not injured by slight freezing of the ground they may be planted quite early in the season (somewhat earlier than corn), and this should be done in order that the plant may have time to mature without danger of injury by early frosts in the fall. The plant withstands drought well, and is, as a rule, remarkably free from insect and fungus enemies.

Sunflowers are sometimes grown between the rows of potatoes. To avoid shading the potatoes too much the sunflowers are planted only in every second, third or fourth row, according to the width of the row, and the plants are thinned to distances of from 20 to 24 inches in the row.

According to the Maine Station the cost of raising a crop of sunflowers is about the same as that of corn, but the experiments of this station indicate that it is "not nearly as profitable a crop to raise as corn," because "with the same cultivation corn produces one-third more protein and nearly twice as much carbohydrate materials as sunflower heads." The same station found that in an average crop of common red clover there was nearly twice as much protein and considerably more carbohydrates than in a crop of sunflowers (see table below).

The heads should be harvested shortly before they are thoroughly ripe to avoid scattering and loss of the seed, but should be carefully dried before storage to prevent molding. Yields of from 4 to 8 tons and more of heads per acre are reported. The seeds are thrashed out with flails, or they may be easily removed from the heads by pressing the latter against a revolving wooden cylinder into which nails have been partly driven, the projecting heads serving the purpose of teeth on the cylinder of an ordinary thrashing machine.[1] It is stated that

[1] American Agriculturist (mid. ed.), 58 (1896), No. 13, p. 266.

in Russia the seeds are to some extent parched and eaten as peanuts are eaten in this country. They are also used as human food in other regions.

The weight per bushel of the seed varies from 25 to 35 pounds, averaging about 30 pounds. The seeds yield from 15 to 20 per cent oil of fine quality by cold pressure, but considerably more, of poorer quality, by hot pressure. The oil is used for illumination, for wool dressing, in paints, and especially for soap making. It is, however, not suited for lubricating purposes. The cold-pressed oil is, as stated, of especially good quality, and is used for a variety of culinary purposes. Sunflower oil is especially highly valued for food purposes in Russia.

The residue, or cake remaining after the extraction of the oil, is a valuable feeding stuff which has been used to a considerable extent for feeding purposes and as a fertilizer in Europe, but has not been experimented with in this country.

Analyses of the sunflower—whole plant, seeds, cake, etc.—compared with other feeding stuffs of a similar character are given in the following table:

Composition of different parts of the sunflower plant and of similar feeding stuffs.

	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.	Nitrogen.	Phosphoric acid.	Potash.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Heads with seeds, fresh	75.62	2.35	4.86	7.88	7.94	1.35	....	....	....
Heads, fresh	81.09	2.79	3.03	6.28	4.55	1.36	2.87	0.78	2.50
Heads, air-dry	7.27	12.63	14.41	34.56	24.40	6.73	....	....	....
Whole plant	84.83	1.33	.95	6.13	4.84	1.92	....	....	....
Corn fodder, green	79.30	1.80	.50	12.20	5.00	1.20	....	....	....
Clover	70.80	4.40	1.10	13.50	8.10	2.10	....	....	....
Stalks, fresh	75.24	1.46	.87	10.36	9.31	2.76	.04	.25	2.64
Stalks, air-dry	7.84	9.80	.68	34.77	33.85	13.06	....	....	....
Leaves, air-dry	16.00	3.50	1.00	35.40	40.00	4.10	....	....	....
Silage (Robertson's mixture) *a*	60.60	3.97	1.88	16.71	6.13	1.62	....	....	....
Corn silage	79.10	1.70	.80	11.00	6.00	1.40	....	....	....
Seeds	7.50	14.22	32.26	14.50	28.08	3.44	2.28	1.22	.56
Cake	8.44	35.56	14.68	20.53	14.86	5.93	5.55	2.15	1.17

a A mixture of corn fodder, horse beans, and sunflower heads (see below).

The Ontario Agricultural College and Experimental Farm has compared sunflowers with different varieties of clover as a feeding stuff for cows. The animals ate the sunflowers readily and the milk and butter produced were of good quality. When fed in large quantities, however, it caused the animals to purge.

In order to make a silage which is a better balanced feeding stuff, i. e., contains a larger proportion of fat and protein than corn silage, the Canada Experimental Farms have proposed a mixture in the silo of corn fodder, horse beans, and sunflower heads (the so-called Robertson mixture).[1] The horse beans, being a leguminous plant and thus rich in

[1] The proportion in which the different crops were used was one-fourth acre sunflowers, one-half acre horse beans, and 1 acre corn. See also U. S. Dept. Agr., Farmers' Bul. 56 (Experiment Station Work—I), p. 7.

protein, increase the proportion of this nutrient in the silage produced, while the sunflower heads increase both the protein and fat, especially the latter. These changes in composition are shown by comparing the analyses of the Robertson mixture silage and corn silage given in the above table.

The Canada Experimental Farms and the Vermont Station have experimented with this silage mixture on milch cows with very satisfactory results.

In experiments during a number of years at the Maine Station with a mixture of this character, using both the whole plant and the heads mixed with blackeye peas or horse beans and corn fodder, it was found that the silage kept well, and although the stalks of the sunflowers were large and coarse, the silage was eaten as readily as that made from corn alone. It is probable, however, that a large part of the plant would have been rejected by stock if it had not been ensiled.

A farmer in Pennsylvania reports having fed sunflower seed to milch cows on an extensive scale with very satisfactory results. He uses the following ration per animal daily: Four pounds of ground sunflower seed, 6 pounds of barley, 15 pounds of clover hay, and 30 pounds of silage.

In addition to its use as an oil-producing plant and as a feeding stuff, the sunflower has been utilized for planting in malarial districts as a protection against paludal fevers. Its stalks have also been used as supports for peas, beans, and other running plants, as a fuel, as a source of fiber, and for paper making. The ashes of the plant are valuable as a fertilizer, being very rich in potash, and a yellow dye is made from the flowers, which also supply abundant nectar for bees.

Although, as shown above, the sunflower may be utilized for a variety of purposes, it is grown in the United States principally for ornamental purposes and for the production of seed, which are sometimes fed to cows, sheep, and pigs, but more extensively used as feed for poultry and birds. It is believed that the agricultural conditions in the United States are such that the uses of the sunflower are not likely to be rapidly or greatly extended.

WINTER PROTECTION OF PEACH TREES.

One of the most serious hindrances to successful peach culture in many parts of the United States is the winterkilling of the fruit buds. The cause of winterkilling appears to be quite different in different parts of the country, and it is therefore to be expected that quite different means may be employed to protect trees during the winter in different localities. In some cases the injury to the fruit buds seems to come from severe freezing in early winter. At the Massachusetts Hatch Station many observations have been made of the buds of a considerable number of varieties of peaches. In regard to this work, Bulletin 17 of the station says: "The results of these observations

show that the buds were largely destroyed before the middle of December, and generally before the temperature had reached 0° or a few degrees below. When it had reached from 15 to 20° below, the buds have nearly all been killed." The results of the station's experiments in protecting peach buds against winterkilling are given in the same report as follows:

For many years numerous experiments have been made at this station to discover some means for protecting the peach fruit buds from injury by cold during the winter; but, although every kind of available covering material that suggested success has been used in protecting the trees in an upright position, they have proved valueless. For the past four seasons in November or early December the roots of about a dozen trees, two or more of a kind, have been loosened on the north and south sides, the trees laid over on the ground, and some left uncovered and others covered with various protective materials.

The first experiment (1888 and 1889) resulted in the destruction of the buds by heating, the trees being covered too closely. In 1889 and 1890 the trees were covered with mats and other light material, and a large percentage of the buds were preserved. In 1890 and 1891 light covering was again used, the following table giving the comparative results between protected and unprotected trees:

Injury to buds of protected and unprotected peach trees.

Variety.	Buds injured.	
	Protected.	Unprotected.
	Per cent.	*Per cent.*
Stump	22	78
Reeves Favorite	23	97
Wager	15	68

At the present date, March 12 [1892], the same varieties, unprotected, show an average of 52 per cent of the fruit buds destroyed, while those protected have only about 10 per cent destroyed. Trees protected in this way are easily set up in the spring and grow well and mature a crop. Of the trees treated in this experiment many were more than 10 years old.

The bulletin recommends that the trees to be protected in this way be previously prepared by cutting off all the roots on the north and south sides during the early summer to facilitate laying the trees down in the fall. It was found that any covering of a coarse light nature, that will not compact, may be used; but thin mats obtained from straw-hat factories give best results. The loosened soil should be pressed back firmly and the upturned roots covered with earth.

At the Illinois Station the use of evergreen branches, cornstalks, and coarse straw for covering peach trees after laying them down gave fairly good results.

At the Kansas Station young peach trees were protected by removing the more wide-spreading branches, shortening the others, drawing the branches in toward the main stem and surrounding them with evergreen branches, which were held in place by cords wrapped around the tops, the bundles thus formed being supported by stakes driven about the tree. The protected trees bloomed more freely than the unpro-

tected ones, but the benefit of the protection was not considered sufficient to make the method practicable. Laying the trees down, staking them, and covering their tops with hay and brush and their roots with soil was tried during two winters. The trees thus protected blossomed more freely than unprotected ones and set fruit well. The unpruned side roots made sufficient growth to support the tree without the roots at the front and back, and the latter were so short and fibrous that it was not necessary to cut them a second time. The trees laid down blossomed earlier than the others, the flower buds opening under the covering in many cases while the buds on standing trees were still closed. This may be a disadvantage in the case of late frosts after the trees are uncovered. The cost of protecting 71 trees in this way averaged about 20 cents per tree.

A recent bulletin of the Missouri Station reports tests of a number of methods of protecting peaches from winterkilling. In the locality of the station winterkilling is thought to be due to other conditions besides mere severe freezing. The most common cause is the freezing of the fruit buds after they have been stimulated into growth by periods of warm weather during winter or early spring. This fact makes it possible to employ a method of protection which can not be employed in cases where winterkilling is due to severe freezing alone. The method reported by the station is based on the fact that light colors absorb less heat from the sun than dark colors. This principle was well illustrated by suspending in the sunlight four thermometers which were coated with whitewash, three of them being colored with aniline dyes—one green, one purple, and one black. A difference of 10 to 15° was frequently observed between the white and the purple bulbs, and on one occasion in very bright sunshine the difference was 21°. It can be readily seen, then, that the green and purple twigs of peach trees would be much more apt to be started into growth by warm weather in winter than whitened ones, and consequently more liable to injury from subsequent cold weather.

The method used consisted in spraying the trees with lime whitewash. Ordinary whitewash did not adhere well in rainy weather, but by using 1 part of skimmed milk to about 5 parts of water and adding 1 pound of salt to each bucketful of whitewash much more satisfactory results were secured. Four sprayings during fall and winter were found sufficient, two being made at first to secure a good coating, followed by two at intervals as required. About one-half bucketful of whitewash was used per tree at each spraying. The total expense, it is estimated, need not be over 10 cents per tree.

This method of protection was tested during two winters. In the winter of 1895–96, which was remarkable for its changeable temperatures, unwhitened buds grew perceptibly during warm periods before whitened ones showed any signs of swelling. By the middle of March all unwhitened buds had made considerable more growth than whitened

ones, and many of them were injured. The whitened trees blossomed but one day later than the others, trees of all varieties being forced into bloom almost at the same time by a sudden change to hot, dry weather. At blossoming time only 20 per cent of the unwhitened buds were without injury, and only a few of these set fruit, while 80 per cent of the whitened buds produced perfect flowers and more fruit set than on the unwhitened trees. Early in March, 1897, while whitened buds were still dormant, unwhitened ones were beginning to swell noticeably. Early in April the unwhitened buds were nearly ready to open and the whitened ones were much less advanced. The whitened trees blossomed from 2 to 6 days later than the others. In the case of three varieties—Heath Cling, Silver Medal, and Wonderful—the whitened trees set more fruit than the unwhitened ones. With Rivers Early fruit set very abundantly and about equally on both whitened and unwhitened trees.

A number of other methods of winter protection of peach trees were tried at the Missouri Station. Drawing the branches together, surrounding the top with cornstalks, and binding the whole into a bundle gave good results. This is not in accord with results of very similar methods tried at the Massachusetts Hatch and Illinois stations, as noted above. The protected trees blossomed two days later and remained in bloom several days longer than those not protected. About 80 per cent of the protected fruit buds were uninjured as against only 20 per cent of the unprotected ones. Some of the trees were uncovered at blossoming time, others later, one tree being left until three weeks after blossoming. Fruit set well under the cover except in the extreme top where the limbs were bound tightly together. For young trees this covering was about as effective and as easily applied as whitewash, but for old trees it can not be readily used.

Shading trees with canvas hay caps proved to be equal to the preceding methods in effectiveness, and with young trees the expense was about the same as spraying with whitewash, but it is thought that the amount of canvas required makes the method too expensive for old trees.

Covering trees with temporary board sheds proved the most effective of the methods tried at the station, but the expense of this was so great as to make its use impracticable under ordinary circumstances. The expense of putting up and taking down the sheds and the cost of lumber, estimating it to last ten years, amounted to $1 per tree per year. Trees thus protected were not injured by either the cold of winter or the winds of spring. In 1897 the trees protected by sheds blossomed four to five days later than the unprotected ones, remained in blossom longer, and set much more fruit than any other trees in the station orchard.

At the Missouri Station whitening the trees, on account of its cheapness and beneficial effects, is considered the most promising method of winter protection. Whether this treatment will prove equally beneficial in other parts of the country can be determined only by trial.

Much will depend on the cause of injury. It is evident that where winterkilling is due to severe freezing alone the use of whitewash will be of no appreciable advantage, since it is used not to protect trees against cold weather, but rather against warm weather, and thus prevent growth during warm periods of winter and delay it in spring. In connection with methods of protection against cold any means of securing thorough maturity of the wood in the fall will be useful, since the thoroughly matured wood is less liable to injury than wood which is not well matured. In some localities it is necessary to keep the orchard in sod, or at least withhold cultivation in late summer and fall, in order to check growth and cause the wood to ripen. Care must also be exercised in the use of fertilizers. A too free use of nitrogenous fertilizers tends to induce a succulent growth of wood and to retard its maturity. It is probable that none of these methods of winter protection will make possible the culture of the more tender varieties of peaches in rigorous climates, but with hardy varieties to begin with the use of some means of protection will undoubtedly add much to the possibilities of peach culture in many parts of the country.

SUBWATERING GREENHOUSE PLANTS.

Tests of subwatering various classes of greenhouse plants have been reported by several experiment stations. Though the methods used have varied considerably, the results have been uniformly in favor of subwatering.

In 15 experiments with lettuce at the Ohio Station, 1,344 surface-watered plants weighed 286 pounds and the same number of subwatered plants nearly 376 pounds, a gain of a little over 31 per cent. The subwatered plants reached marketable size from a week to ten days earlier than the others. All these plants were subwatered during about one-half their period of growth—that is, while in flats. In one case where plants were carried through their entire period of growth by the respective methods of watering, a gain of about 120 per cent was shown in favor of subwatering, 115 surface-watered plants of 10 different varieties weighing 15 pounds and the same number of subwatered plants over 33 pounds. At the Ohio State University subwatered lettuce yielded 20 to 30 per cent more than surface-watered lettuce. Lettuce rot was very troublesome on the surface-watered beds, but did not injure subwatered plants. Similar results were obtained with lettuce rot at the Nebraska and West Virginia stations. At the latter station subwatered lettuce reached marketable size from ten days to two weeks earlier than surface-watered lettuce and yielded fully 25 per cent more. At the Wisconsin Station the yield of lettuce was 27 per cent greater on a subwatered bed than on a surface-watered one in one test and 25 per cent in another. The subwatered plants were much more tender and crisp than the others.

With radishes the Ohio Station found that subwatered plants reached marketable size earlier and yielded more than the surface-watered

ones, the difference being more marked with long radishes than with turnip-rooted ones. At the Ohio State University subwatered radishes yielded 50 per cent more than surface-watered ones and were earlier and of better quality. Surface watering caused a proportionally greater growth of tops and less growth of roots than subwatering. Work at the West Virginia Station showed that in the case of long-rooted radishes subwatering had a very beneficial effect on earliness of maturity, weight of product, and percentage of marketable roots, but in the case of turnip-rooted radishes no effect was noticed.

Besides the lettuce and radishes already noted, tests were made at the Ohio Station with cucumbers, tomatoes, spinach, parsley, cauliflower, beets, sweet peas, smilax, roses, gladioli, carnations, violets, chrysanthemums, and ferns. These plants were benefited in different degrees, but all were benefited sufficiently to warrant the use of subwatering. Subwatering had a decidedly beneficial effect on cucumbers and a less noticeable effect on tomatoes. Subwatered carnations produced better flowers with longer, stiffer stems. Favorable results with carnations were also obtained at the Michigan Station, twice as many flowers being cut from subwatered plants as from others. The results with chrysanthemums were no less satisfactory. At the Wisconsin Station subwatered coleus, geraniums, and petunias in pots plunged in the soil gave good results. The increase in the yield of carrots by subwatering was 75 per cent, while with beets it was only 6 per cent. At the West Virginia Station subwatering increased the earliness of spinach, but had little effect on turnip-rooted beets. Subwatered parsley plants reached marketable size by the time surface-watered ones were one-third grown. Tomatoes were noticeably benefited by subwatering. At the Delaware Station 90.6 per cent of the cauliflower plants set in the subwatered bed produced heads as against only 65.5 per cent of those set in the surface-watered bed, and the heads averaged 20 per cent heavier in the former case than in the latter.

As to methods of subwatering there has been considerable difference of practice among the stations. Data are too meager for a careful comparison of these methods, yet an examination of them will show some of their strong and weak points. At the Ohio Station subwatering was done by means of 2½ or 3 inch drain tiles placed below the soil in water-tight benches. At first the benches were made of matched lumber laid in white lead, but the boards swelled and bulged up, displacing the tiles and causing leakage. Better results were secured from the use of rough lumber, with the larger cracks covered with lath and the whole bottom coated one-half inch thick with cement. A still more satisfactory arrangement was the use of benches with slate sides and tile bottoms, covered with cement as before, the whole being supported on a framework of gas pipe. The tiles used for the distribution of water were laid end to end in rows about 2 feet apart, the end of the last tile of each row being raised so as to project above the

bench for the admission of water. The joints were sometimes cemented to hold the tile together, but this was not considered necessary. Besides drain tile, gas pipe, with small holes at intervals of about a foot, and iron pipe, with a narrow slot along one side, were used with success, but were more expensive than tile. One and one-fourth-inch iron and lead pipes, perforated every 4 inches, were used at the West Virginia Station. The lead pipes were more expensive than the iron ones, but were more durable on account of freedom from rust. Tiles were more economical than either. At the Delaware Station 3-inch drain tiles were used, the joints being filled with cement at the bottom and left open at the top. A similar arrangement of drain tiles was used at the Ohio State University, and in addition 3-inch sewer pipe and 1¼-inch iron pipe, with one-fourth-inch holes every 2 feet, were tested with good results. An inexpensive method of subwatering employed at the Nebraska Station consisted of an old, worn-out hose, with small holes 3 inches apart, and a bench with a double-boarded bottom. While the bench was not absolutely water-tight, fairly good results were nevertheless secured. The same was true at the Michigan Station, where an ordinary bench was made nearly water-tight by a wash of cement to fill the cracks. Here 2½-inch tile were laid from 2 to 3 feet apart, and care taken to have the openings between the separate tiles as nearly equal as possible to secure even distribution of water.

The Wisconsin Station has recently reported a method of subwatering without the use of either tiles or pipe. An ordinary bench, after being carefully leveled, was lined inside with galvanized iron, the joints being soldered, thus forming a water-tight pan 2 or 3 inches deep. A layer of bricks was set edgewise in the pan to conduct the water to the soil above. The water was supplied from a tank above the bed through a rubber tube, which extended from the tank to the pan. To prevent flooding the bed, in case the water was allowed to run too long, the tank was so constructed that it could be made airtight. The water, therefore, could escape through the rubber tube only as air entered through it, and, since the tube extended to one-fourth inch from the bottom of the pan, the water in the pan could never become more than one-fourth inch deep. When the bricks were laid flatwise the water was not evenly distributed to the soil and more frequent watering was required. The use of hollow building tile in place of brick gave good results. Other modifications of this system of subwatering were recently reported by the Indiana Station. A zinc pan 3 or 4 inches deep was used to line the bench. The pan was first provided with overflows 1½ inches from the bottom. Later, water gauges were put in, so that the height of the water in the pan could be seen at any time. A layer of brick was set on edge in the pan. The lower edges of the bricks were chipped off to form channels for the freer distribution of water throughout the pan. Vertical tubes extending from above the soil to the bottom of the pan were provided for the admission of water.

While an examination of all these methods of subwatering, with data now at hand, can not result in determining which is best, yet such an examination is of importance as indicating the many modifications which may be employed to adapt a method to particular conditions. Various other modifications have been suggested, though not definitely reported upon, as, for instance, the use of cinders or gravel in any water-tight bed in place of brick in a metal pan. Though little has been done in the way of comparison of different methods under like conditions, it is a significant fact that nearly all methods have proved successful, the only exception to this, so far as reported, occurring at the Indiana Station, where drain tile with cemented joints and benches with bottoms of matched lumber were used. The reasons given for the lack of success are the impossibility of making a water-tight bench of matched lumber and of securing an even distribution of water throughout the bench.

As to the expense of subwatering, the West Virginia Station reports that the extra cost for material necessary to fit a house 20 by 50 feet for subwatering was only $17.72 where tiles were used in benches made water-tight by means of matched lumber. This was less than 4 cents per square foot of bench. The cost of the brick and zinc pan at the Indiana Station was 13 cents per square foot of bench. It seems probable that the latter method has the advantage in durability, but whether this is enough to counterbalance the difference in cost can not be said.

Although there is considerable difference of opinion in regard to the merits of the various methods of subwatering, the advantages of subwatering over surface watering have been clearly shown by the experiments reported. The difference in yield for one year alone is believed to be sufficient in many cases to counterbalance the increased cost made necessary by subwatering. In addition to the increased yield and earliness and lessened injury from disease already noted, other points have been brought out in favor of subwatering. The water is distributed with greater uniformity and hence the crops make a more even growth. The soil remains friable, which is an advantage, especially where clay soil is used. Subwatering is more economical of water, time, and labor.

BACTERIAL DISEASES OF PLANTS.

Bacteria are micro-organisms which perform many important functions by the united energy of countless numbers. While exceedingly minute, they reproduce so rapidly that their abundance makes up for what they lack in size. It must not be supposed that all bacteria are injurious. Beneficial bacteria are found in the dairy, where they lend flavor to the dairy products. Many kinds of fermentation are brought about by bacteria or allied micro-organisms. To them clover and other leguminous plants are indebted for their ability to assimilate the free

nitrogen of the air. It is thought probable that the peculiar flavor and aroma of some highly esteemed tobaccos are due to the action of some of these agents.

Although for some time past many infectious diseases of man and animals have been known to be due to bacteria, it is only within recent years that such plant diseases have been conceded. One of the first diseases of plants demonstrated to be due to bacteria was the fire blight of apples and pears, the first note of which emanated in 1882 from what is now the Illinois Station. At the present time at least two score diseases of plants are either known to be or are suspected as being caused by the activity of bacteria. Many of these diseases affect plants, and some of them are briefly described below. All these diseases have been studied more or less by the agricultural experiment stations and by the Division of Vegetable Physiology and Pathology of this Department.

Apple and pear blight.—This disease, which perhaps is commonest upon the pear, where it is known as pear or fire blight, also attacks apples, quinces, and allied fruits. Its bacterial origin was first demonstrated at what is now the Illinois Experiment Station, and later by the New York State Station and other stations, and the United States Department of Agriculture. The methods of infection and prevention have been well worked out. The parts affected are the flower clusters, young fruit, and the more succulent woody tissues and foliage. The disease runs down the living bark to the larger limbs and trunk. While it attacks the leaves to some extent, the discoloration and wilting of the foliage is mostly due to the destruction of the twigs. The affected portions are quite conspicuous, and all portions below the point reached by the spread of the bacteria will be healthy. While the disease is progressing the discolored portion of the bark blends gradually with the normal bark, but when the disease has run its course the line is sharply drawn. From a long series of experiments conducted at this Department it was learned that the chief means of spreading the contagion was through the visits of bees, the first point of infection seeming to be at the nectaries. The disease is accompanied by a flow of gum, and it is thought probable that the first flowers are infected by bees, flies, etc., that have visited the gummy deposits.

Cutting away and burning all diseased twigs will prevent the recurrence or spread of the disease. In pruning, the twig should be cut a few inches below the dead tissue. In rapidly growing succulent tissues the disease spreads most rapidly, the bacteria there finding the most favorable conditions for their development. Anything that will check the growth will aid in preventing the spread of the disease. The use of nitrogenous fertilizers and severe pruning resulting in rapid growth should be avoided. In addition to pruning, some investigators recommend spraying trees thoroughly with Bordeaux mixture as an extra precaution. It will do no harm to the tree, and may result in good other than the prevention of the blight by destroying other fungi.

Bacterial disease of beans.—This disease, which was probably first described in 1892, manifests itself upon the pods in soft, water-soaked, spreading spots. The leaves or stems are said to be similarly affected, but as the pods are the portion most conspicuously attacked, the disease is sometimes considered a pod disease. The beans within the pod are also affected and, when ripe, if permitted to mature, are deeply wrinkled. It is thought that diseased seed may aid in the distribution of the trouble, and all distorted and wrinkled seed should be rejected when planting. The exact kind of bacteria causing this disease has been carefully studied and named at this Department, and it has been found that the disease attacks nearly all kinds of beans, lupines, and probably peas. Care in the selection of seed and spraying the growing plants with Bordeaux mixture will possibly tend to reduce the amount of injury.

The bacterial disease of cabbage and allied plants.—The first published account of this disease appeared in the Kentucky Station Report for 1890. The investigator was not at that time able to complete his studies, but reported it as a serious disease of cabbage. Later, at the Iowa Station, an organism was found that attacked ruta-bagas, producing a peculiar browning or blackening of the woody tissue as shown in cross section of the root. Since then the disease has been studied at various places, notably at this Department and at the Wisconsin Station. It has been found to attack cabbage, cauliflower, ruta-bagas, turnips, and quite a number of allied plants, some of which are common weeds. This disease causes the stunting, distortion, and wilting of the part of the plant attacked, finally resulting in a sort of dry rot. Sometimes a wet rot develops as a result of other causes. On the leaves the disease begins with a yellowing near the margins, the veins becoming brown or black. It spreads from the margin toward the stems. After reaching the stem it may spread to other leaves or up or down the plant. If the diseased stems be cut transversely, the woody tissue will be seen to be browned or blackened; hence the name, brown or black rot of cabbage. It is especially destructive to cabbage, the loss in one locality in Wisconsin having been estimated at more than $100,000 in three years. This disease has also caused heavy losses in western New York, on Long Island, around Washington, D. C., and elsewhere.

The disease is spread in a number of ways, entrance into the plant being secured through the bites of gnawing insects and through the openings along the leaf margins. The presence of these openings, called water pores, may be detected by the exudation of drops of water during cool weather. The agency of winds in the distribution of the bacteria is somewhat in dispute. There are indications that the plants may also become contaminated through the seed bed, manure, and soil. On this account the precaution of rotation and choice of fertilizers should be carefully looked after. No manure containing cabbage refuse should be used, and the seed bed should be in a new place each year.

With these precautions, supplemented by the destruction of insects and removal during the season of diseased plants comparatively little loss need be sustained.

Bacterial disease of celery.—Several diseases of celery have been described as due to bacteria, but sufficient study has not been given them to determine their identity or difference. A disease mentioned in a New Jersey Station Report for 1891 describes the affected leaves as badly blotched with brown, the diseased spots having a watery appearance. The disease spreads through the leaf in about three days, and when it gains entrance to the tender blanched stalks it causes their decay even more rapidly. It is thought that thorough and timely spraying with any of the better known fungicides will probably keep the disease in check. A somewhat similar, if not identical, disease has been recently described in Italy, showing the wide distribution of the malady.

Corn blight.—This was first described in Illinois Station Bulletin 6 and is of bacterial origin. The first indication of the disease is in the dwarfed condition of the young plants over patches of varying extent. Later in the season a stalk or hill here and there may be affected. On close examination the leaves appear yellowish, and the roots, in bad cases, will be rotted away. The bottom of the stalk and the tissues of the joints will be discolored. The surface exhibits brown spots, with a nearly transparent jelly-like substance adhering to them. Later, the leaf sheath shows spots of various sizes, varying in color from red to brown, and appearing as though half rotten. If the leaf sheath be stripped off the inside will be found covered with the jelly-like mass. Occasionally the ears are attacked, the husks presenting the same appearance as the leaf sheath. The ear becomes soft and wilted. The most serious loss occasioned by this disease is to the young plants, as it stunts and kills them. No definite methods are suggested for its prevention.

A bacterial disease of sweet corn has been lately reported by the New York State Station. The symptoms closely resemble those witnessed in the ordinary rolling of corn during dry weather. The affected plants wilt and the leaves wither and die. There is no discoloration and no rolling until after the plant is dead. Careless observers are liable to think dry weather is the cause of the trouble. As the plants die in wet weather as well as in dry, this theory is not tenable. If examined, the woody tissues will be found to contain masses of bacteria long before there is any indication of wilting, and by the time the plant appears affected the conductive vessels of the plant will be gorged with them. It is thought the chief method of dissemination is by diseased seed. It is also probable that stable manure, made by animals fed on diseased cornstalks, may aid in spreading the infection. Varieties differ in their susceptibility. Only those known to be resistant should be planted.

Cotton-boll rot is a bacterial disease which has been described by the Alabama Station. As its name indicates, it attacks the bolls. There

is no external evidence of its presence until the contents of the bolls begin to decay; then the outer portions of the boll also show signs of decay. Insects and the wind are thought to be instrumental in the dissemination of the disease. Picking and burning all diseased bolls as soon as discovered, and the selection of seed from uninfected regions are suggested as preventive measures. Some of the leaf diseases of cotton have also been attributed to bacteria, but more evidence must be presented before their bacterial origin will be accepted as conclusive.

Bacterial disease of cucumbers and melons.—This disease, which has been studied at several experiment stations, and particularly at this Department, is characterized by the sudden wilting and collapsing of the plant. This is due to the clogging of the channels of water supply of the plant by the extremely rapid and abundant growth of the bacteria which live in these channels and cause the disease. Insects are instrumental in spreading the disease.

Bacterial disease of eggplant, tomato, and Irish potato.—This disease has been investigated at a number of stations, but the most important contribution to our knowledge of it was made by this Department, an account of which was published in Bulletin 12 of the Division of Vegetable Physiology and Pathology. The disease attacks the eggplant, tomato, Irish potato, and allied plants. The first conspicuous indication of this disease is the sudden wilting of the foliage. This may occur on a single shoot or the whole plant may become affected. It usually results in the death of the plant. If the plant is young, the stem generally shrivels, changes to a yellowish green, and finally becomes black. The disease seems to progress more rapidly in young than in old plants and in hot weather than in cold. If stems are transversely sectioned the woody tissue will be seen to be brown or black. In the case of the potato, the tuber is also attacked and destroyed, the dark ring being often very conspicuous in a section of the tuber. An offensive soft rot often follows the dark discoloration. Potato beetles and other leaf-eating insects are among the principal means of spreading the disease. By combating them it is believed that its spread may be checked to a considerable degree. The removal and burning of all tops and a rotation of crops is also recommended.

It is claimed there are other potato diseases in which bacteria attack the tuber, notably one causing a soft rot. This disease has proved very destructive, especially in Germany. It may be prevented to a considerable extent in stored potatoes by spreading them thinly in well-aired bins.

The foregoing are brief descriptions of some of the more important bacterial diseases to which economic plants are subject. So far as we know, none of these diseases are in any way injurious or infectious to man or animals, and need not be feared on that account. It will be observed that, like the contagious diseases of man and animals, the prevention of these diseases in plants depends to a considerable degree on what may be called the proper sanitary conditions.

THE PRESERVATION OF GRAPE JUICE AND SWEET CIDER.

The manufacture of unfermented grape juice and of sweet cider assumes considerable proportions in many localities, but difficulty is often experienced in preparing a product which will "keep," i. e., does not ferment.

Fermentation is due to the presence of micro-organisms in the juice or cider, and may be prevented by sterilizing the latter as well as the vessels used in connection with the bottling of the product. Heating is the simplest, safest, and most effective means of sterilizing, but great care is necessary in order to so control the temperature as to secure thorough sterilization without injuring the flavor of the product. A report of the Canada Experimental Farms gives an account of a series of experiments on the best means of sterilizing grape juice. The conclusion, which probably applies to sweet cider as well as to grape juice, was that "the natural flavor of grape juice may be preserved intact by raising the temperature of the juice gradually to 170° F., keeping it at this point for ten minutes and then quickly bottling it, taking care to use absolutely air-tight and thoroughly sterilized vessels. These vessels should be taken from a tank or kettle of boiling water, immediately filled, and corked or covered with the least possible delay."

The use of antiseptics, such as salicylic acid, is considered unwise. They are unnecessary, and unless used with great caution may be injurious to health.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all feeds and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain, to 80 pounds in silage, and 90 pounds in some roots.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorin, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc, and is one of the most important constituents of feeding stuffs.

Albuminoids is the name given to one of the most important groups of substances classed together under the general term protein. The albumen of eggs is a type of the albuminoids.

Carbohydrates.—The nitrogen-free extract and fiber are usually classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, besides real fats, wax, the green coloring matter of plants, etc. The fat of feed is either stored up in the body as fat or burned, to furnish heat and energy.

MISCELLANEOUS TERMS.

Micro-organism, or **microscopic organism**, is a plant or animal too small to be seen without the aid of a compound microscope.

Bacterium (plural, **Bacteria**) is the name applied in common to a number of different or closely related microscopic organisms, all of which consist of single short cylindrical or elliptical cells or two such cells joined end to end and capable of spontaneous movement. Many kinds of bacteria are harmful and cause diseases and other injurious effects, but many are beneficial. Among the latter are those which give aroma to tobacco and flavor to butter and cheese, and those which enable leguminous plants to use the free nitrogen of the air.

Inoculation is the introduction of bacteria or other organisms into surroundings suited to their growth with a view to producing the effects which are the result of their activity.

Culture, as here applied to bacteria or other organisms, is the product of their growth under artificial conditions.

Pure culture is a culture containing one kind of organism. Pure cultures of yeasts are used in wine making, and pure cultures of bacteria are used in butter and cheese making, and for other purposes, to insure a uniform product.

Leguminous plant is a plant of the botanical order Leguminosæ, the principal representatives of which are clover, peas, beans, etc.

Tuber is the term applied to the enlarged under-ground portion of a plant, which, as in the case of the potato, is not a true root, but an enlarged under-ground stem.

Humus is the name applied to the partially decomposed organic (animal and vegetable) matter of the soil. It is the principal source of nitrogen in the soil.

Nitrogen is the most expensive of the three essential fertilizing ingredients (the other two being potash and phosphoric acid), and exists in soils and fertilizers in three distinct forms, viz, as organic matter, as ammonia, and as nitrate.

Nitrates are the most readily available forms of nitrogen. The most common forms are nitrate of soda and nitrate of potash (saltpetor).

Nitrification is the process by which the highly available nitrates are formed from the less active nitrogen of organic matter, ammonia, salt, etc. It is due to the action of minute microscopic organisms.

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag. Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble phosphoric acid.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water, and are believed to be nearly if not quite equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvanite, muriate of potash, sulphate of potash, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash. The potash in them is in the form of carbonate.

Specific gravity of solid substances is the ratio of the weight of a given bulk of the body to that of an equal bulk of water; or, stated in another way, the ratio of the weight of the substance in air to its weight in water.